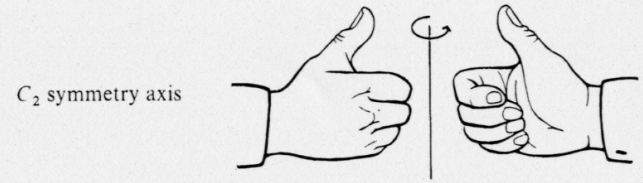
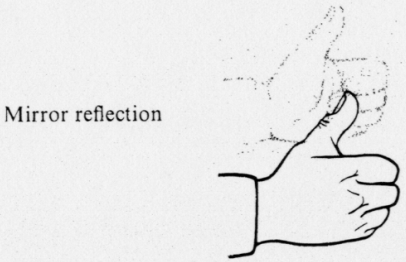
Box 2-5 SYMMETRY OPERATIONS

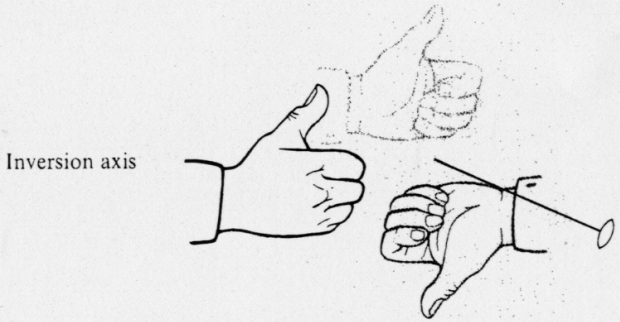
Symmetry operations are rotations, translations, or other transformations that leave an object unchanged. Point symmetry operations are a special class of transformations that not only leave an object unchanged, but also leave at least one point in the object stationary. For example, if a 180° rotation exchanges two identical subunits, they are related as shown.



The rotation is called a C_2 symmetry axis. This is a type of point symmetry because the point on the axis itself remains stationary in space. A mirror reflection can also generate a symmetric arrangement of two subunits. This is also a point symmetry because parts of the object at the mirror plane do not move during the reflection.

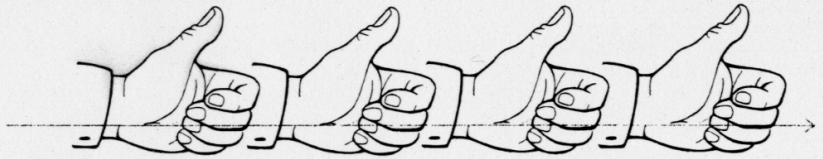


An inversion axis is a simultaneous C_2 rotation and reflection through a perpendicular mirror plane. This too is a point symmetry operation.



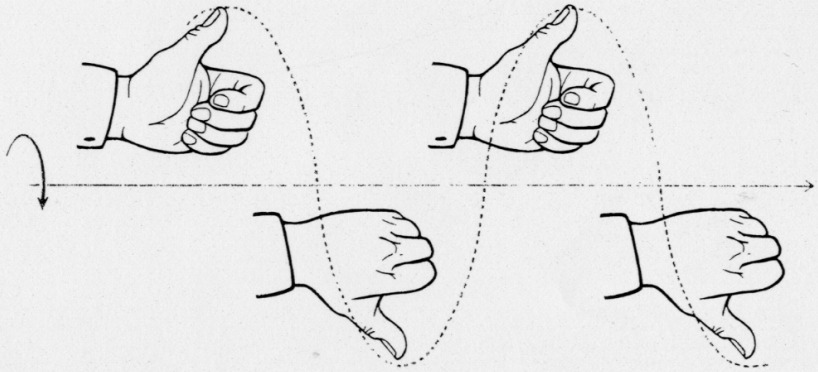
The point symmetry group of an object is a list of all the symmetry operations that leave it unaltered. A completely unsymmetric object is group *E*. Only the identity operation, which does nothing at all, leaves the object stationary and unchanged. Other examples of point groups are given in the text.

Other symmetry operations involve translations as well as possible rotations or other operations. These are called space symmetry operations. An example is a simple translation along an axis.



Translation

If a translation is combined with a rotation, the result is called a screw axis. It generates a helix or ribbon. The example shown combines a C_2 rotation with a translation along the C_2 axis. Additional discussion of symmetry is found in Chapter 13. An excellent introduction to symmetry operations is given in P. W. Atkins, *Physical Chemistry* (San Francisco: W. H. Freeman and Company, 1978).



Screw axis

[Drawings by Irving Geis.]